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Social and Behavioral Sciences**CPSYC 2014****Brain Dynamics of Mild Cognitive Impairment (MCI) from EEG Features**Norsiah Fauzan^{a*}, Nur Hurunain Amran^a^a*Faculty of Cognitive Science and Human Development, 94300, University of Malaysia Sarawak.***Abstract**

MCI is a clinical state intermediate between elderly normal cognition and dementia featuring cognitive impairment on neuropsychological testing. The purpose of this research is to identify EEG features of MCI in comparison with the normal aging. Mini mental State Examination were used as screening tool from twenty participants and 14 participants were considered normal and 6 MCI. MCI group revealed the increase of beta2 power over the right anterior region in comparison with the normal healthy aging. Both groups showed a predominance distribution of theta and alpha at the frontal regions, but the presence of theta are highest at the parietal and temporal area indicating signs of cognitive decline among the MCI. A reduction of delta at the prefrontal area (F3, Fz, F4) and the central regions (C3, Cz, C4) for the normal suggests associated cognitive decline at the hippocampal area.

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Keywords: EEG; mild cognitive impairment.

1. Introduction

MCI is a clinical state intermediate between elderly normal cognition and dementia featuring memory complaints and cognitive impairment on neuropsychological testing, but no dementia [3-9]. In studies carried out in memory clinics, 10-15 per cent of people with MCI went on to develop dementia in each year. Since the number of individuals with AD is expected to increase considerably in the near future, reliable treatment and early diagnosis of MCI are critical. Recent research have demonstrated that QEEG is useful for investigating AD [1,4]. Topographical EEG power changes are believed to reflect early signs of cortical atrophy and/or compensatory cortical reorganization during the early stages of the disease.

2. Statement of Problem

The prevalence of neurodegenerative diseases is rising worldwide as the aging population continues to grow at a vigorous pace. Alzheimer's disease (AD) is the most common neurodegenerative disorder and its treatment requires early detection before its progression to dementia. Several studies suggests 5 to 20 percent of the elderly have some form of mild cognitive impairment (MCI) of one form at any one time . Since the number of individual with AD is expected to increase considerable in the near future, reliable treatment and early diagnosis of MCI are critical.

3. Objectives

The elderly group within 60-70 years with MCI are at increased risk of developing dementia. The main objective of this research is to identify and analyse the Brain dynamics of MCI from the EEG signal features that will contribute to a better understanding of brain dynamics of MCI patients and the degree of EEG abnormality and cognitive impairment. Many people with MCI is at the possible risks of developing dementia, this approach allows people to plan ahead while they are still able to do so and can have earlier access to treatments as well as practical information, advice and support.

4. Method

5.1 Instrumentations

Materials and Instruments used were Mini mental state examination (MMSE) for the assessment of subjects' cognitive status and identifying the symptoms of cognitive disorders. Quantitative electroencephalogram (qEEG) were used to record the EEG from 19 sites using the electrodes positioned according to the International 10/20 system.

5.2 Participants

Twenty subjects volunteered for the research aged within the range of 60-75 years old. Mini Mental State Examination (MMSE) were used as screening tool to separate persons with cognitive impairment from those without MCI. MMSE detect cognitive impairment by evaluating orientation, attention, recall, language and ability to follow commands. A score higher than 23 is considered normal, although performance varies with the person's age and education. The results showed that 14 participants were considered normal aging group whereas 6 MCI with the score below 23 .

5.3 Procedures

- i. Informed consent were obtained from the participants before qEEG recordings and screening were done.
- ii. EEG recordings from 19 sites using elctrodes set in elastic cap and positioned according to 10-20 International System (Fp1, Fp2, F7, F3, Fz, F4, F8, T3,C3, Cz, C4, T4, T5, P3, Pz, P4, T6, O1, and O2). The ground electrode was placed in front of Fz. The left and right mastoids served as reference for all electrodes. Data were recorded with a band-pass filter of 0.3–70 Hz and digitized at a sampling rate of 250 Hz.
- iii. Eyes closed (3 Mins)
- iv. Eyes opened (3 Mins)

5.4 Analysis of of Individual Frequency bands

The spectral analysis for the four EEG bands were imported into Microsoft excels for computation of z scores for each of the measurements used in QEEG such as absolute power (μV^2), frequency (Hz) and symmetry. The z scores were computed from the mean of absolute power (μV^2), and to be compared across the different normally distributed sets of data from the international 10/20 system (Fp1, Fp2, Fp3, Fz, Fp4, F7, F8, C3, Cz, C4, P3, P4, T3, T4, T5, T6, O1, O2) from the two groups (Normal vs MCI). The Z value indicates how “deviant” an individual’s score is from the mean. In the case of qEEG data, the Z-score indicates whether there is deficient or excessive activity in a given frequency for a given electrode (or group of electrodes).

6.0 Results and Discussion

6.1 Beta2 power

The mean values of absolute amplitude power (microV) and the mean Z scores were obtained in theta (4.0-6.0 Hz), alpha 1 (8.0-10.5 Hz), alpha 2 (10.5-13.0 Hz), beta 1 (13.0-20.0 Hz), and beta 2 (20.0-40.0 Hz) frequency bands respectively. The main findings indicates greater Beta 1 and beta 2 power in MCI subjects with cognitive deficits than in normal healthy aging group. Beta 2 showed greater predominance over the frontal regions (FP1, FP2, F3, F4, F8) temporal region (T3, T4, T6) and parietal (P3, P4) shown in Fig. 1a

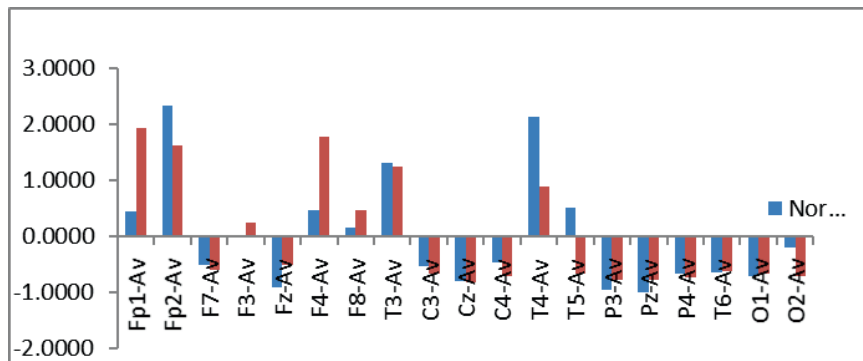


Figure 1 (a) : Z score of Beta 2 (EC resting state)

The increase of beta 2 power over the frontal region, highest at Fp1 and F8 with the right predominance at the anterior region distinguished the level of anxiety among the MCI in comparison with the healthy elderly. Both groups showed higher beta2 at frontal and temporoparietal regions than the normal controls in each band. Previous research by Yamada et al [10] associated the increase of beta 2 power with anxiety type depression in their study of EEG power and coherence among the presenile and senile depression. The anxiety type was distinguished from the retardation type with the increase of beta 2 power.

6.1 Theta/alpha

Next, the analysis revealed the excessive presence of slow wave activity (theta and alpha) in Normal and MCI group as shown in Fig.2 during the Eyes closed (EC) resting state over the frontal and parietal region (FP1, FP2, F8 and P4). (Figure 2 a, 2 b, 3 a and 3 b). MCI group were highest at P4 and higher at prefrontal (F8). Previous studies

has demonstrated that in subjects with cognitive decline, there is an increase of theta and alpha power [7] as compared to the normal aging. The increase of theta could be seen at the frontal regions (Fp1, Fp2, F8) and at the temporoparietal regions as indicated at (P4) and (T6). The increase of theta and beta 2 reduced the presence of alpha at the frontal and occipital regions among the MCI group. (Figure 3 a, 3 b). These area plays the role in the way an individual observe the world and process information. On the whole theta and alpha could be considered reliable that might differentiate the normal aging and MCI group. Increasing theta have been reliably associated with AHC atrophy as well as with memory deficits, a major risk for the development of Alzheimers' disease and MCI subjects [8]. The amygdalohippocampal network is a key structure in the generation of theta rhythm. The atrophy of AHC determines increasing memory deficits. More specifically, theta oscillations increased at most of the regions (frontal, temporal and occipital area) during the eyes open (EO) conditions that showed the lack of attention.

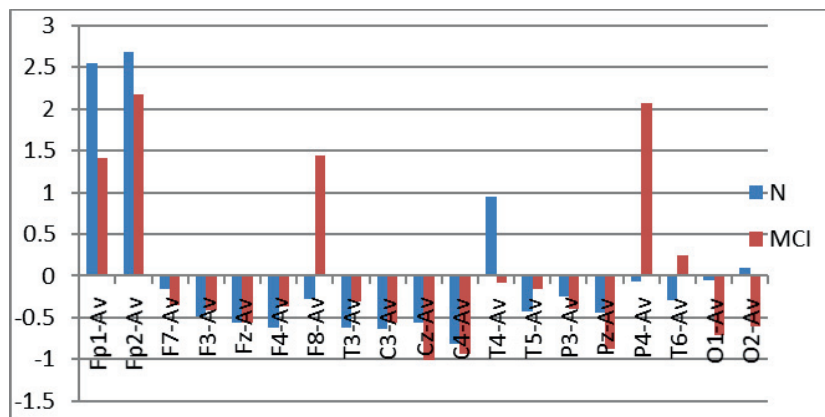


Figure 2 (a) : Z-score of Theta : Normal vs MCI (EC)

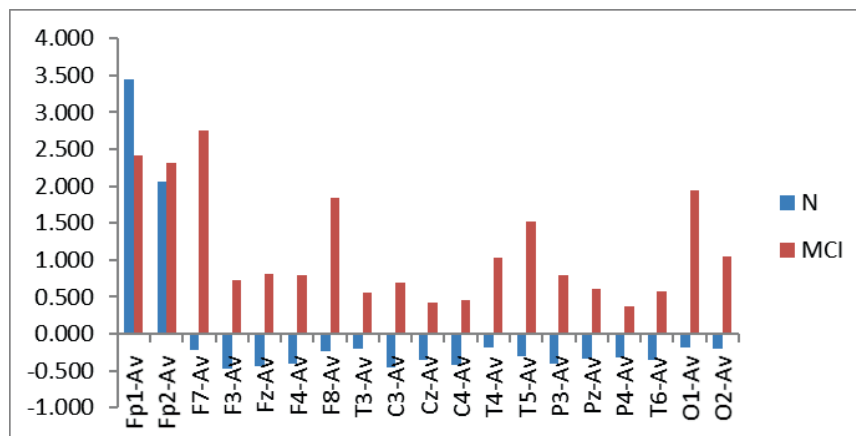


Fig 2 (b) : Z score of Theta : Normal vs MCI (EO)

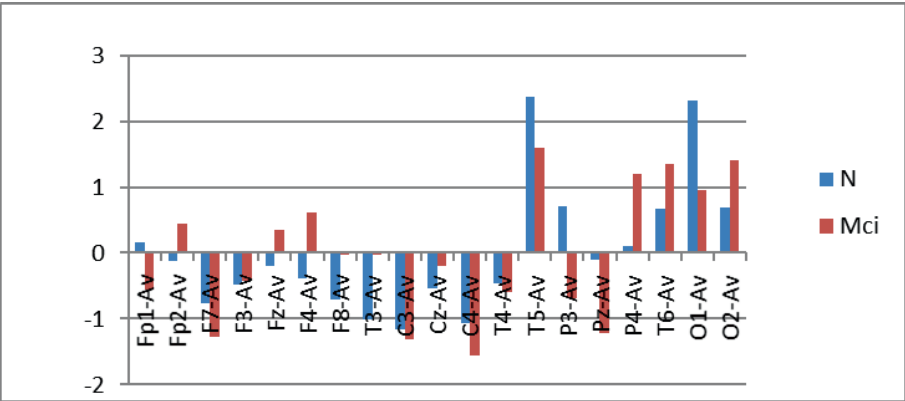


Figure 3 (a) : Z score of Alpha : Normal vs MCI (EC)

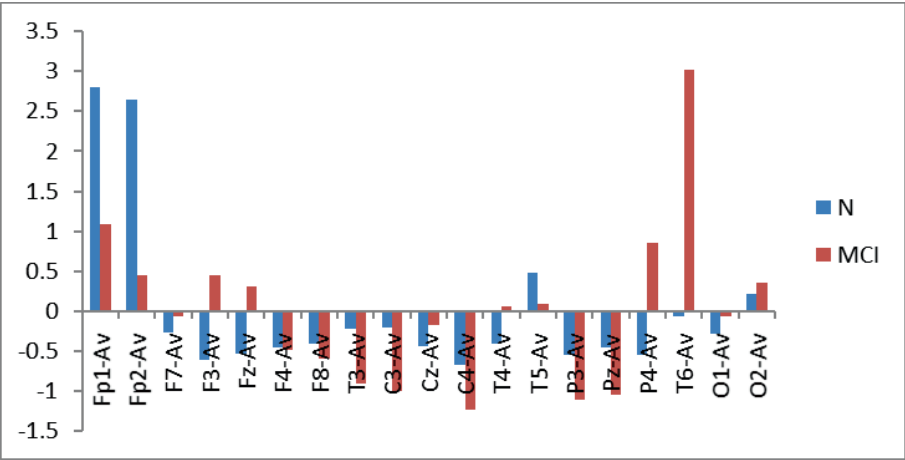


Figure 3 (b) : Z score of Alpha: Normal vs MCI (EO)

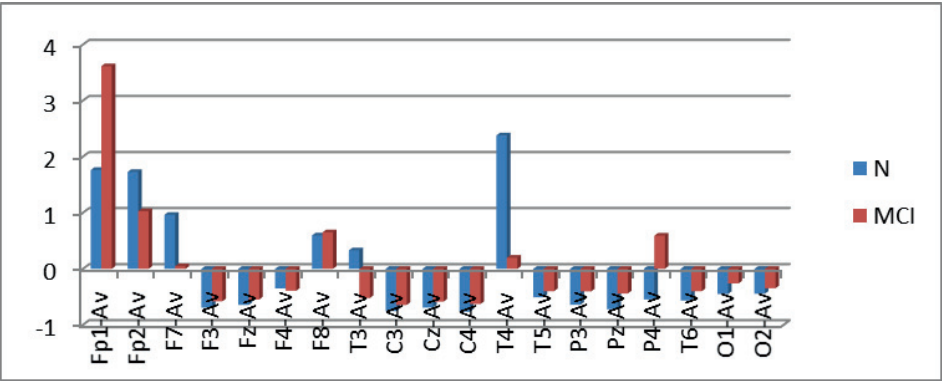


Figure 4 (a) : Z score of Delta: Normal vs MCI (EC)

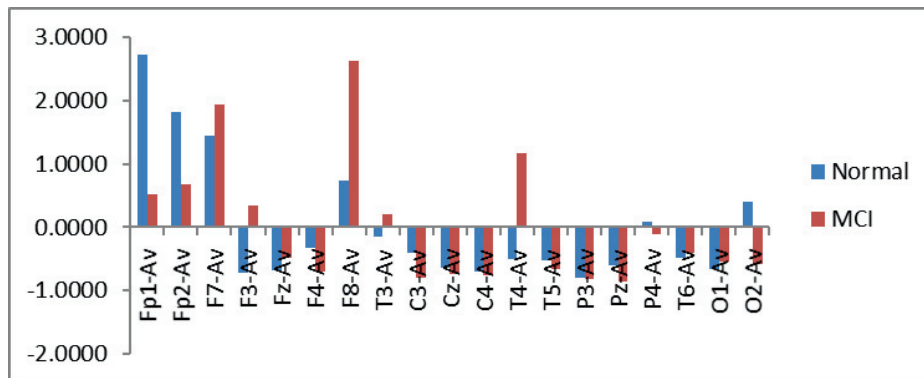


Figure 4 (b) : Z score of Delta: Normal vs MCI (EO)

Fig. 4a and 4b shows the increase in delta at the frontal area during the eyes closed conditions and increased over F7, F8 and T4 among MCI during the eyes opened resting state. In the spectral band power the severity of CVD was associated with increased delta power and decreased alpha2 power.

7. Conclusion

The observation and analysis of EEG features among the MCI group revealed the increase of beta 2 power over the right anterior region in comparison with the normal healthy aging which distinguished their level of anxiety. Both groups showed a predominance distribution of theta and alpha at the frontal regions, but the presence of theta are highest at the parietal and temporal area indicating signs of cognitive decline among the MCI. The increase of theta and alpha power could be considered reliable in differentiating the normal aging and the MCI group. Increasing theta have been reliably associated with AHC atrophy as well as with memory deficits, a major risk for the development of Alzheimers' disease and MCI subjects [8]. A reduction of delta at the prefrontal area (F3, Fz, F4) and the central regions (C3, Cz, C4) for the normal are associated with cognitive decline or hippocampal area.

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